Sources and Loads

Photo: Ohio EPA

Section 5: Sources and Loads

5.1 Approach and Direction

From the perspective of reducing the presence of persistent toxic substances in Lake Erie, the Great Lakes Water Quality Agreement (GLWQA) suggests that the Problem Definition stage analysis of the Lakewide Management Plan (LaMP) should include the following:

- A definition of the threat posed by critical pollutants to human health or aquatic life, singly or in synergistic or additive combinations with other substances, including their contribution to the impairment of beneficial uses.
- An evaluation of information available on concentrations, sources, and pathways of the critical pollutants in the Great Lakes system, including all information on loadings of the critical pollutants from all sources and an estimation of total loadings of the critical pollutants by modeling or other identified methods.
- Development of information necessary to determine the schedule of load reductions of critical pollutants that would result in meeting Agreement objectives, pursuant to Article VI of the Agreement and including steps to develop the necessary standard approaches and agreed procedures.

As a preliminary step to meeting these requirements, the Sources and Loads Subcommittee of the Lake Erie LaMP Work Group was given the following charge that primarily addresses the second bullet listed above:

1. Describe the status and trends in concentrations and loads of pollutants that are causing, or have the potential to cause, beneficial use impairments in Lake Erie.
2. Identify the major pollutant sources and the relative contribution of those sources to the beneficial use impairments.
3. Provide a scientific basis for sound management decisions for reducing, removing, and eliminating the pollutants from the Lake Erie system.
4. Identify gaps in the information needed to identify the sources and loads, and recommend the monitoring needed to fill the gaps.

The first step was to identify and review all of the existing databases that might be of use to calculating loads and tracking down sources. This led to the preparation of the *Characterization of Sources and Source Data for the Lake Erie LaMP Report* (Myers *et al.*, in prep.). The results of this report are summarized in Section 5.3, and partially address charges one and two. The potential sources are categorized as either point or nonpoint, and generic descriptions of size, location, and available data by sector are presented. The next steps will be to characterize ambient concentrations of pollutants of concern, to track down sources more extensively, and to continue to develop and implement a workplan that will complete the Sources and Loads Subcommittee's charge.

5.2. Critical Pollutants and Pollutants of Concern

The initial list of chemicals selected for intensive review was identified by the beneficial use impairment assessment reports. The chemicals are presented in Table 5.1. Of these chemicals, the Lake Erie LaMP Management Committee designated mercury and PCBs as **critical pollutants** for priority action. Mercury and PCBs are pollutants documented as creating impairment across the Lake Erie basin, particularly in relation to fish and wildlife consumption advisories. As the Lake Erie LaMP progresses and specific problems and causes become more well-defined, additional chemicals may be designated as critical pollutants.

The Sources and Loads Subcommittee also compiled a second, more comprehensive list of pollutants and their degradation products designated by a variety of agency programs as being pollutants of concern throughout the Lake Erie basin. This list is presented in Table 5.2. These pollutants include those listed in Table 5.1. This expanded list allows the subcommittee to begin evaluating information on all the pollutants of concern in Lake Erie and to determine the suitability of the data for estimating loads and whether the data represent a contaminant source or pathway to the Lake Erie ecosystem.

Table 5.1 Pollutants Causing Beneficial Use Impairments in the Lake Erie Basin

BENEFICIAL USE IMPAIRMENT	CAUSES OF IMPAIRMENT
Fish & Wildlife Consumption Restrictions	*Fish*- PCBs, mercury, lead, chlordane, and dioxins *Wildlife*- PCBs, chlordane, DDE, DDT, and mirex
Fish Tumors or Other Deformities	PAHs
Bird or Animal Deformities or Reproduction Problems	PCBs, other organochlorines, dieldrin, DDE, PAHs, nitrates
Degradation of Benthos	Sediments contaminated with PCBs, other organochlorines, pesticides, PAHs
Restrictions on Dredging Activities	PCBs and heavy metals
Eutrophication or Undesirable Algae	Phosphorus
Recreational Water Quality Impairment	PCBs[1], PAHs[1], Exceedances of *Escherichia coli* or fecal coliform guidelines

[1]PAHs are the basis for a human contact advisory in the Black River Area of Concern (Ohio), and PCBs are the basis for a human contact advisory in the lower Ottawa River, part of the Maumee Area of Concern (Ohio). The human contact advisories were issued by the Ohio Department of Health and indicate that it is not safe to go into the water in these areas.

Table 5.2 Contaminants Identified as Lake Erie LaMP Pollutants of Concern.

Contaminant(s)	Common Source(s)
Organochlorine insecticides and biocides	
DDT[2,3,4,5,6,8]	Historical use on crops, microcontaminant in dicofol.
• *DDD, DDE*	
Chlordane[2,4,5,8]	Historical use on crops and for termite and ant control.
• *Alpha-chlordane , Gamma-chlordane, cis-nonachlor, trans-nonachlor*	
Dieldrin[2,4,5,6,8]	Historical use on crops, termite and moth control.
Toxaphene[3,4,5,6,8]	Historical use on crops, topical insecticide.
Mirex[3,4,5,6]	
• *Photomirex*	Historical use for fire ant control and flame retardant.
Alpha-hexachlorocyclohexane	Agricultural and topical insecticides.
Beta-hexachlorocyclohexane	
Delta-hexachlorocyclohexane	
Gamma-hexachlorocyclohexane	
Industrial organochlorine compounds or byproducts	
PCBs[2,3,4,5,6,8]	Transformers, hydraulic fluids, capacitors, heat transfer fluids, inks, casting waxes.
Dioxin (2,3,7,8-TCDD)[4,5,6]	Combustion byproducts, contaminant in pentachlorophenol wood preservative, other chlorophenols and derivatives, including herbicides.
1,4-Dichlorobenzene[4,5]	Mothballs, household deodorants, other biocides.
Pentachlorobenzene[4,5]	Chemical synthesis.
1,2,3,4-Tetrachlorobenzene[4,5]	
1,2,3,5-Tetrachlorobenzene[4,5]	
Pentachlorophenol[4,5]	Chloroalkali plants, wood preservatives.
Hexachlorobenzene[4,5,8]	Byproduct of chemical manufacturing, historical wood preservative and fungicide.
3,3'- Dichlorobenzidine[4,5]	Plastic manufacturing, glues and adhesives, dyes and pigments for printing inks.
4,4'-Methylenebis(2-chloroaniline)[4,5]	Plastics, adhesives.
Polynuclear aromatic hydrocarbons (PAHs)[4,5,8]	
Anthracene, Benz(a)anthracene	Coal, oil, gas, and coking byproducts, waste incineration, wood and tobacco smoke, and forest fires, engine exhaust, asphalt tars and tar products.
Benzo(a)pyrene, Benzo(b)fluoranthene	
Benzo(k)fluoranthene, Benzo(g,h,i)perylene	
Chrysene, Fluoranthene, Phenanthrene	
Indeno(123-cd)pyrene	
Trace Metals	
Alkyl lead[4,5,6]	Leaded gasoline.
Cadmium[4,5]	Batteries, pigments, metal coatings, plastics, mining, coal burning, metal alloys, rubber, dye, steel production.
Copper[6]	Same as cadmium, plus plumbing and wiring.
Lead[6]	Same as cadmium, plus solder.
Zinc[6]	Same as cadmium, plus roofing.
Mercury[3,4,5,6]	Batteries, coal burning, chloroalkali plants, paints, switches, light bulbs, dental material, medical equipment, ore refining.
Tributyl Tin	Antifouling paint, mildewcide, plastic stabilizer.
Current-use herbicides[7]	
Atrazine, Cyanazine, Alachlor, Metolachlor	Agricultural herbicides.
Other Contaminants	
Total phosphorus, Nitrate-nitrogen	Fertilizers and sewage.
Fecal coliform, *Escherichia coli*	Sewage and animal waste.
Total suspended sediments	Soil erosion.

[1]Contaminants indented are degradation products; those shown in italics have been identified as chemicals of concern; [2]Lake Erie Chemicals of Concern identified by Lake Erie LaMP in 1994; [3]Great Lakes Initiative Bioaccumulative Chemical of Concern (BCC); [4]COA-Tier 1 or Tier 2 contaminant, [5]Binational Toxics Strategy contaminant; [6]Contaminant identified by the IJC or in Remedial Action Plans; [7]U.S. EPA; [8]Canadian Toxic Substance Management Policy-Track 1

5.3. Results of Characterization of Sources and Source Data Report

This section provides a brief summary of the *Characterization of Sources and Source Data Report* (Myers *et al.*, in preparation). Many contaminants arising from past and present agricultural, industrial, and municipal sources are reported to have the potential to impair the beneficial uses of Lake Erie and to threaten the quality of aquatic life and human health. To adequately characterize the contribution of these varied and sometimes subtle sources, a description of what is known about point and nonpoint sources within the basin is needed. By focusing on broad categories of pollutant sources as the first step of the process, a better understanding of available data, data gaps, and data limitations can be developed.

Of all the Great Lakes, Lake Erie receives the highest discharge volume of domestic wastewater. Wastewater or sewage treatment plants (STPs) represent a potentially significant source of pollutants. The sewage treatment process is essentially designed to remove suspended solids and, for larger STPs, is enhanced to remove 90 percent or more of the influent phosphorus load to meet the objectives of the Great Lakes Water Quality Agreement. Incidentally, as a result of the chemical properties of other pollutants of concern, STPs also represent a significant line of defense against the discharge of contaminants to the environment. For example, from studies elsewhere in North America, removal efficiencies of polychlorinated biphenyls (PCBs) by STPs can be as high as 97 percent (Durell and Lizotte 1998). Nevertheless, typical concentrations of PCBs in STP effluents range from 5 to 55 ng/L (Fikslin and Greene 1998). Municipal/industrial programs, such as industrial pre-treatment and municipal sewer use bylaws, also contribute significantly to minimize the input of contaminants to STPs. In Ontario, *optimization* of the treatment process further improves treatment efficiency without modification of the existing facilities and reduces operating costs.

Industrial sources both within the watershed and beyond the Lake Erie watershed were displayed in the report, using the U. S. Toxic Release Inventory (TRI) and the Canadian National Pollutant Release Inventory (NPRI). It documented that air emissions are significant, hence the need to consider areas beyond the Lake Erie watershed when considering possible sources.

Releases of mercury and PCBs from industrial facilities were reported in TRI and releases of mercury were reported in NPRI. Of the mercury and PCB releases reported in TRI and the mercury releases reported in NPRI, virtually all of the 1996 releases were to the atmosphere. The TRI and NPRI programs can be used to identify sources, but because they represent process-based estimates and not actual releases to the environment, they cannot be used to compute loads.

Unlike contaminants from municipal and industrial facilities that discharge directly to surface waters, agricultural chemicals applied to the land surface normally do not pose a significant or immediate threat to surface waters. Once agricultural chemicals have been applied to the land surface, their ultimate environmental fate is decided by several factors. These include the method of application, the time elapsed from application, the physical and chemical properties of the chemicals, and the physical characteristics of the land where the chemicals were applied. Approximately 67 percent of the land in the Lake Erie basin is used for intensive, row crop agriculture, most of it concentrated in the western basin (Environment Canada and U.S. EPA 1995). This is much higher than the agricultural use around the other Great Lakes. Nutrients, pesticides and bacteria are issues linked to agricultural practices. Field applied nitrogen loss to streams can be as high as 50 percent, phosphorus loss can be as high as 17 percent (Fuhrer *et al.* 1999). The use of buffer strips, conservation tillage, no-till and a variety of best management practices can greatly reduce the loss of nutrients to streams, and are in use throughout the basin. Pesticide loss can be as high as 10 percent (Larson *et al.* 1997). Atrazine use is significant in the basin and environmental concentrations reflect proximity to application.

The suitability of available environmental and ancillary data to describe contaminant concentrations and loads in the Lake Erie basin was evaluated in the report. Data were from point and nonpoint sources, the connecting channels, tributaries, and the atmosphere. Particular emphasis was placed on analyzing data for PCBs and mercury. Although the various contaminant monitoring programs may be adequate for their intended purposes, results of the analysis for the source characterizaion report indicate that available data for PCBs, organochlorine pesticides, mercury, and PAH compounds are not suitable to describe the occurrence and distribution of contaminant concentrations or to compute contaminant loads. An explanation of the selection criteria used to screen the databases for applicability of the data to determining ambient contaminant concentrations or loads is presented in Appendix B.

The minimum criterion established to characterize concentrations of contaminants discharged from point sources was 10 observations if all reported data were above the detection limit. If some of the data were less than the detection limit, at least 25 percent of the observations should be above the detection limit. The minimum criterion established to compute loads discharged from point sources was at least 25 percent of the observations above the detection limit. The detection limits for concentrations of PCBs, organochlorine pesticides, PAHs and mercury reported by point source monitoring programs in the United States and Ontario are too high to measure the typically low concentrations of these contaminants found in STP discharges. PCBs were monitored at 15 facilities in the United States, but only five percent of the nearly 1,000 observations were reported above the detection limit.

Mercury was regulated at 21 facilities in Ontario in 1995 but, like PCBs, the percentage of observations indicating a detection of mercury was less than 25 percent, too low to compute a load. In the United States, 170 point sources monitor and report mercury concentrations, but only 23 percent of the reported observations were above detection limits. A large number of samples were collected at many point sources and very few of the reported concentrations were less than the detection limit for total phosphorus, nitrate-nitrogen and total nonfilterable residue (suspended solids). Basin-wide characterization of concentrations and computation of loads for these substances appear to be possible.

Tributary and connecting channel monitoring programs were evaluated for their adequacy to characterize concentrations and compute loads. The minimum criterion established for the characterization of concentrations was at least 10 samples. If censored data (data below the detection or reporting limit) were included, the minimum criterion was that at least 50 percent of the samples be reported above the detection limit in at least 25 samples. The minimum criterion for the computation of loads was at least 50 samples in which at least 25 percent of the analyses are reported above the detection limit. In addition, samples must represent the range of streamflows measured at the collection site. Data for organochlorine compounds, PAHs and mercury reported for tributaries or connecting channels did not meet these minimum criteria - mercury and PCBs in particular did not. Only the atmospheric data from the Integrated Atmospheric Deposition Network (IADN) were sufficient to estimate loads for the contaminants for trace organic contaminants, including PCBs. Data from 1995 to 1998 that are suitable for the computation of mercury deposition are available from the Mercury Deposition Network (MDN). Nutrient data appeared to be suitable to characterize concentrations and to compute loads.

Although environmental data from point sources and surface waters for most trace organic substances were not suitable for characterizing concentrations or computing loads, other available data may be used in their place for some types of analyses. Near-surface streambed and lakebed sediments can indicate the recent deposition or resuspension of contaminants to the aquatic environment. Fish tissue can help integrate the bioaccumulation of contaminants by aquatic life and the potential for human health impacts. The detection frequency of organochlorine and trace metal contaminants in aquatic sediments is markedly higher than in water. Contaminants such as PCBs, organochlorine pesticides, PAHs, and mercury that are reported with few or no detections in point source effluents and surface waters are reported at concentrations above detection limits at frequencies of 25 percent or more in aquatic sediments.

The weight of evidence from the locations of point and nonpoint sources, their potential chemical impacts, and the known contaminant impacts in water and sediments as determined by comparison to guidelines suggests that the Lake Erie basin as a whole, and in particular the western portion, is impaired by contaminants. Contaminant concentrations in the environment often reflect proximity to sources, particularly those contaminants for which local sources are significant relative to long-range transport. Atrazine, nitrate, and phosphorus concentrations in water, and concentrations of mercury and PCB in sediment, are just a few examples.

5.4 Results of USGS Bed Sediment Report and Implications

In cooperation with the Lake Erie LaMP, the U.S. Geological Survey (USGS) analyzed contaminants of concern in the surficial bed sediments of the Lake Erie-Lake St. Clair Basin within U.S. boundaries (USGS in prep.) All samples were taken as part of the National Water Quality Assessment (NAWQA) Program of the USGS. The sediment report describes the occurrence and distribution of contaminants of concern in streambed sediments, compares bed sediment concentrations to guidelines that indicate contaminant levels either acutely or chronically toxic to aquatic macroinvertebrates, and discusses the extent and magnitude of contamination within and outside of areas of concern (AOCs). The study utilizes four large databases that cover portions of the Lake Erie-Lake St. Clair Basin: the National Sediment Inventory (NSI), Ohio Sediment data Inventory (OSI), U.S. EPA-Fully Integrated Environmental Locational Decision Support system (FIELDS) database, and the USGS-NAWQA sediment data. Only surficial bed sediment samples collected within the top five inches of sediment over the period 1990 through 1997 were evaluated to reflect recent conditions.

The concentrations of selected contaminants of concern in surficial sediments were compared to three freshwater bed sediment quality guidelines: 1) Ontario Ministry of the Environment guidelines for the protection and management of Canadian freshwater sediments; 2) U.S. EPA guidelines for Great Lakes sediments; and 3) Environment Canada and the Great Lakes guidelines for ecosystems throughout Canada and the Great Lakes basin. Results are discussed in relation to the potential toxicity of the contaminant to biota according to these regional bed sediment quality guidelines. Only results of analysis for which sample concentrations were found to be equal to or greater than guidelines indicating a probable or severe effect level were reported. Finding that a sample contains a contaminant concentration equal to or exceeding a probable or severe effect level does not imply such effects are actually occurring at a location. Rather, these findings suggest that sediments with concentrations exceeding these guidelines have the potential to impair aquatic life. Further investigation to determine the presence of adverse effects on aquatic biota at these locations is warranted.

The study found that chlordane, total PCBs, and total PAHs were most often detected at concentrations equal to or greater than a probable and/or severe effect level within AOCs. The study showed that the 75th percentile concentrations of benzo(a)pyrene, chlordane, dieldrin, total PAH, and total PCBs were greater than the probable effect level in tributaries of the Lake Erie-Lake St. Clair Basin within AOCs. The 75th percentile concentrations of dieldrin and total PAHs were also greater than probable effect levels in samples from a few streams in major urban areas outside AOCs. In Michigan, the highest concentrations of anthracene, total PAH, phenanthrene, benz(a)anthracene, chrysene, benzo(a)pyrene, total PCB and chlordane in surficial bed sediments were found in the Clinton River AOC, Detroit River AOC, River Raisin AOC, and River Rouge AOC, respectively. In Ohio, the highest concentrations of these contaminants were found in the Maumee and Cuyahoga River AOCs.

Basinwide, the greatest number of contaminants equal to or greater than a probable or severe effect level were found in samples from the Ottawa River within the Maumee AOC. Samples from the River Raisin AOC contained the highest concentrations of PCBs in the Lake Erie-Lake St. Clair Basin; some of which exceeded the severe effect level by more than 100 times. Concentrations of total DDT, dieldrin, lindane, and other isomers of hexachlorocyclohexane in surficial bed sediments were detected equal to or greater than a probable effect level at a range of urban and agricultural sites throughout the basin. The detection of these contaminants in urban and agricultural areas may indicate residues of past use of these compounds in both areas are still reaching the lake. Mirex and hexachlorobenzene were not detected in bed sediments in the Lake Erie-Lake St. Clair Basin. Unfortunately, detection limits for these two contaminants were too high to make the data useful for evaluating occurrence, distribution and potential effects on aquatic life. Further investigation of these contaminants using methods capable of detecting lower concentrations may be needed.

Concentrations of trace metals and arsenic were detected more frequently but at lower concentrations relative to effect levels than were organochlorine compounds or PAHs. The study showed that the 90th percentile concentrations of arsenic, cadmium, lead, and zinc were greater than the probable effect level in major tributaries both within and outside of AOCs. The 90th percentile concentration for mercury samples was greater than the probable effect level within AOCs but not outside of AOCs. The highest concentrations of arsenic, cadmium, copper, lead, mercury, and zinc were found in the Clinton River AOC, Detroit River AOC, and River Raisin AOC, respectively, in Michigan; and in the Ottawa River (Maumee AOC) and Cuyahoga River AOC, respectively, in Ohio. Samples from the Trenton Channel of the Detroit River AOC contained the highest concentrations of mercury in surficial bed sediments in the Lake Erie-Lake St. Clair Basin; some of which were equal to or greater than the probable and the severe effect levels. The dominant factor influencing the distribution of sample concentrations of cadmium, copper, lead, and mercury in samples of surficial bed sediments appears to be urban land use. Because of the potential presence of arsenic and zinc in geologic materials and because of past use in agricultural pesticides, distinguishing the relation between land use and concentrations in bed sediments of arsenic and zinc in the Lake Erie-Lake St. Clair Basin may be more complex than for other contaminants.

Data from this report will provide a baseline of information for long-term trend analysis and source track down of contaminants. A forthcoming report will include analysis of data from Lake Erie proper as well as the watershed. The report will attempt to describe how sources of contaminants, land use, and natural factors may affect the concentrations of contaminants in bed sediments and if the relation between the occurrence of sources and contaminant concentrations can be related.

5.5. Initiation of Source Track Down Process

The next step in the Lake Erie LaMP process to identify sources and provide a scientific basis for sound management decisions will be to track down sources more extensively. Known point sources can be identified from the data compiled for the *Characterization of Sources and Source Data Report*. Maps of discharge locations, pesticide use, agricultural areas, abandoned landfill sites and other land use will be compared to ambient water column concentrations, aquatic biota tissue concentrations, and sediment concentrations to identify major source areas and the most highly contaminated areas in the lake. An assessment of whether or not the most contaminated areas and major sources already have been targeted for priority action will be accomplished by identifying and cross-referencing implementation and remediation actions already underway. The Lake Erie AOCs have already been identified as priority areas for source control and remediation. This exercise may further confirm the RAP sites as priority areas, but may also point out additional areas where further action or attention may be needed, whether it is monitoring, additional research or remediation.

Several projects independent of the Lake Erie LaMP are underway which may support the source track down effort. The Great Lakes Binational Toxics Strategy (BTS) is investigating sources of contaminants of concern to the Great Lakes both within and outside of the basin. This strategy is designed to further identify pollutant sources and develop and implement the actions needed to move us closer to the goal of virtual elimination of persistent toxic substances in the Great Lakes. Several contaminated sediment and landfill remediation projects recently were completed or are underway in the River Raisin, Ashtabula River, and Ottawa River/Maumee AOCs. The Lake Erie LaMP Action Plans for PCB and mercury will also help in the source track down.

An analysis will be done of the ambient concentrations of pollutants in all media compared to the specific objectives listed in Annex 1 of the GLWQA, and possibly other more recent objectives, such as the U.S. Great Lakes Water Quality Guidance (GLI). This analysis will offer the potential to identify other chemicals as *likely to impair* pollutants and ensure a thorough evaluation of sources and potential critical pollutants. Selected databases examined for the *Characterization of Sources and Source Data Report* will also be used for these purposes.

A significant amount of data appropriate for the analysis of the impacts of contaminated bed sediment on benthos, fish and humans are available, but not readily accessible. National, state, and provincial governments have analyzed contaminants in bed sediment as well as fish tissue in generally discrete, but sometimes widespread, locations throughout the Lake Erie basin. However, the information gathered has never been compiled into one, basinwide data set facilitating the overall usefulness of assessing the impacts of contaminants in sediments to the lake. An effort has been initiated in cooperation with the U.S. EPA, the Lake Erie LaMP, Ohio EPA, U.S.G.S., and Environment Canada to compile such a database to look into a cause and effect type relationship between concentrations of contaminants of concern found in sediments and concentrations found in aquatic organisms.

Uptake of a number of key compounds, such as mercury and PCBs, has led to numerous fish consumption advisories in Lake Erie. Pinpointing the location of contaminated sediments and assessing the resulting effects on the biota will help the Lake Erie LAMP and various other managers with decisions concerning sources of the contaminants and designing recommendations for their cleanup.

5.6 Conclusions

There is no question that Lake Erie is in flux. To better understand pathways of critical pollutants, additional research is needed on changes in food web dynamics and the linkages in energy and contaminant flow between the lake bottom and the water column. For example, contaminant concentrations in fish have fluctuated over the years, even as point and nonpoint source loads appear to have decreased. Is this a reflection of food web changes, impacts from non-indigenous invasive species, climate change or something else? While it may be possible to further decrease contaminant loads into the lake, it is also important to understand what is happening to the contaminants already in the lake.

Over the long term, it is important to note continually the data gaps, prioritize the importance of those gaps and identify actions to fill them. Although models are valuable to calculate and evaluate total loads of critical pollutants over time, the use of models for Lake Erie must be considered carefully, given the current flux of the Lake Erie food web. Once the major sources of contaminants and the most seriously contaminated areas are identified, it is recommended that resources and remedial actions be focused immediately on those areas rather than spent on further attempts to estimate total loads.

There are many activities already underway to reduce loads of contaminants of concern, including pollution prevention, waste minimization, various regulations that restrict discharge, remediation of contaminated sediments and old landfills, agricultural BMPs, etc. All of these activities will be reviewed at some point as to their utility in meeting the goals of the Lake Erie LaMP.

The Lake Erie LaMP also recognizes that there may be potential and emerging sources of contamination. The potential for an accidental contaminant spill does exist and has been addressed at all levels of government. Even though containment and cleanup contingency plans have been created for the most part, there is still the possibility that a spill could have some impact on the ecosystem. Increasing populations, land use changes and increased impervious surfaces have changed the way we view some sources and the contaminant pathways. Future assessments will need to consider these changes.

5.7 References

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